GREEN ACTION CENTRE

DOCUMENTS

GAC #5

RE DSM

Economic, Load, and Environmental Impacts of Fuel Switching in Manitoba

MANITOBA HYDRO

August 2012

Manitoba Hydro

EXECUTIVE SUMMARY

This report outlines the economic, load and environmental impacts of using electricity (including geothermal technology) instead of using natural gas for space and water heating purposes. The economic impact is assessed from the customer's and the utility's perspective along with a high level assessment of provincial leakage (i.e. the net impact of changes to extra-provincial natural gas purchases and electricity export sales). The environmental (greenhouse gas emission) impact is assessed from both a provincial and a global perspective. The scope of this assessment does not consider future uncertainty associated with a number of influential factors, including potential electricity rate structure changes (e.g. inverted rates) and potential changing Canadian and US government policies related to greenhouse gas (GHG) emissions. The assessment also does not account for any costs which may result from large-scale upgrading of Manitoba Hydro's electrical infrastructure due to significant energy demand changes.

Space Heating

The following table summarizes the load, economic and environmental impacts of using electricity instead of natural gas for space heating in a typical Manitoba residential home. Impacts are analyzed over the life of the equipment (i.e. 25 years). Values in brackets indicate a negative impact from an economic perspective and represent a reduction in GHG emissions from an environmental perspective.

Impact of Converting from Natural Gas to Electric Space Heat

Average Residential Home from Natural Gas to:	Electric Furnace	Geothermal (SCOP 2.5)
Annual Energy Load Impact		
Electric Load Impact (kW.h)	16,391	6,556
Natural Gas Load Impact (cu.m)	(1,776)	(1,776)
Economic Impact		
Utility Perspective (Electric)	($3,223)	($1,563)
Utility Perspective (Natural Gas)	($4,107)	($4,107)
Customer Perspective	($7,737)	($11,276)
Integrated Utility / Customer Perspective	($15,067)	($16,946)
Net Provincial Inflow (Leakage)	($6,271)	$1,061*
Annual Environmental Impact		
Manitoba (kg CO_2e/year)	(3,374)	(3,374)
US - MISO Region** (kg CO_2e/year)	0 to 12,293	0 to 4,917
Net Global**(kg CO_2e/year)	(3,374) to 8,919	(3,374) to 1,543

**The provincial inflow benefits will be offset by higher cost of geothermal units relative to the cost of natural gas furnaces and air conditioners (i.e. estimated at $2,000 to $3,000).*

***The US-MISO Region and Net Global impacts are shown as a range, which includes the impact under today's emission policies in export regions and recognizes what the potential impacts could be under more aggressive emission policies in export regions.*

From the customer, utility and provincial leakage perspectives, there are substantive benefits when customers use natural gas rather than electricity for space heating purposes. The directional impact for each of these factors are also the same when using natural gas for space heating relative to using geothermal systems, except for the provincial leakage impact. In the latter case, a more complete analysis would need to account for the higher cost of geothermal furnace units which are imported into Manitoba relative to the cost of importing natural gas furnaces and air conditioners.

Using electricity for space heating in Manitoba as opposed to natural gas will reduce GHG emissions in Manitoba; however the global GHG emissions will be higher due to reduced electricity exports from Manitoba (i.e. electricity exports would no longer displace fossil generation). In the future, the global impacts may change depending on future environmental policies (e.g. if a cap on GHG emissions was introduced within the U.S. in the future, changes in Manitoba electricity exports would potentially have no incremental impact on US GHG emissions). Given the possible future outcomes, the US and global environmental impacts are shown as a range of possible outcomes.

Water Heating

The following table summarizes the impact of using electricity instead of natural gas for water heating applications in a typical Manitoba residential home, analyzed over the life of the equipment (i.e. 10 years). Values in brackets indicate a negative impact from an economic perspective and represent a reduction in GHG emissions from an environmental perspective. The impacts are assessed for using electric hot water tanks relative to a conventional natural gas unit.

Impact of Converting from Natural Gas to Electric Water Heat

Average Residential Home from:	Conventional Gas to Electric Water Heat
Annual Energy Load Impact	
Electric Load Impact (kW.h)	3,489
Natural Gas Load Impact (cu.m)	(491)
Economic Impact	
Utility Perspective (Electric)	($10)
Utility Perspective (Natural Gas)	($317)
Customer Perspective	($727)
Integrated Utility / Customer Perspective	($1,054)
Net Provincial Inflow (Leakage)	($297)
Annual Environmental Impact	
Manitoba (kg CO_2e/year)	(933)
US - MISO Region* (kg CO_2e/year)	0 to 2,617
Net Global* (kg CO_2e/year)	(933) to 1,684

**The US-MISO Region and Net Global impacts are shown as a range, which includes the impact under today's emission policies in export regions and recognizes what the potential impacts could be under more aggressive emission policies in export regions.*

Similar to space heating, there are benefits to using natural gas relative to electricity for water heating purposes. The environmental (GHG) impacts of using electricity rather than natural gas for water heating applications are similar to space heating however the impacts are much lower on a per unit basis as the equipment uses less electricity/natural gas.

Manitoba - Fuel Choice Trends & Impacts

A trend towards more customers using electricity for space and water heating is evident in Manitoba. For water heating, a trend toward the increased use of electric water heaters is currently taking place and is forecast to continue into the future. For example, virtually 100% of the new home market is installing electric water heaters. A small shift towards the increased use of electricity for space heating is expected however this shift has been declining due primarily to the continuation of low natural gas prices.

As indicated in the following table, the impact of fuel switching from natural gas to electricity is approximately 3% of the expected 2030/31 domestic electric demand for both space and water heating and a 5% reduction in the provincial natural gas demand forecast in 2030/31.

2011 Load Forecast	Portion of 2011 Forecast Attributed to Fuel Switching 2030/31		
	Total Load Forecast	Space & Water Heating	% of Load
Net Firm Energy (GW.h)	32,465	874	**3%**
Total Natural Gas Sales (10^6m^3)	1,924	-103	**-5%**

There are substantive economic impacts from the increased use of electricity (i.e. fuel switching) for heating purposes based on Manitoba Hydro's 2011 energy forecasts. The following table presents the net economic costs to the utility and to customers over a 30 year period. In addition, reduced export power revenue is not fully offset by the reduced imported natural gas purchases and is therefore expected to result in lower net provincial cash inflows.

Net Economic Costs & Provincial Leakage

2011 Forecast	Net Cost
Utility Perspective (Electric)	$132 million
Utility Perspective (Natural Gas)	$69 million
Customer Perspective	$311 million
Electricity Export Revenues	$505 million
Natural Gas Import Purchases	($251 million)
Net Provincial Leakage	$254 million

The following table provides the environmental (GHG) impact of fuel switching in space and water heating as per the 2011 forecasts.

Potential Annual GHG Impacts
(Attributed by Region due to Energy Use)

Year	Manitoba (tonnes C02e / year)	US - MISO Region* (tonnes C02e / year)	Net Global Impact* (tonnes C02e / year)
2012/13	(11,970)	38,753	26,783
2022/23	(154,166)	0 to 496,268	(154,166) to 342,102
2032/33	(203,699)	0 to 687,473	(203,699) to 483,774

** The US-MISO Region and Net Global impacts are shown within a range, which includes the impact under today's emission policies in export regions and potentially what the impacts would be under more aggressive emission policies in export regions.*

Hypothetical Impact of Total Conversion

The following analysis provides insight into the hypothetical maximum load impacts if all customers in Manitoba replaced their existing space and water heating equipment with an alternative natural gas, electric or geothermal system. The results simply provide a technical range of hypothetical impacts in terms of electricity and natural gas demand in Manitoba. The table provides:

- the existing electricity and natural gas load for space and water heating in Manitoba; and
- the hypothetical potential electricity and natural gas loads under extreme fuel conversion scenarios (i.e. all customers immediately fuel switch to either all natural gas use, all electric use or all geothermal use for space and water heating purposes).

Impacts are based on the electric and natural gas forecast for 2011.

Hypothetical Annual Load Impact
If All Customers in Manitoba Immediately Switched to One Type of Heating Fuel

	Natural Gas (1000 m3)	Electricity (GW.h)	Geothermal SCOP 2.5 (GW.h)
Current load situation - space heat	938,723	3,473	67
Current load situation - water heat	194,925	1,097	0
A. Immediate fuel switch to natural gas - space	1,339,429	---	---
A. Immediate fuel switch to natural gas - water	349,251	---	---
B. Immediate fuel switch to electric - space	---	11,341	67
B. Immediate fuel switch to electric - water	---	2,482	---
C. Immediate switch to geothermal - space	---	---	4,603
C. Immediate switch to geothermal - water	---	---	2,081

The magnitude of the hypothetical potential impact of all customers switching to electric space and water heating would add 7,868 GWh and 1,385 GWh respectively of annual electric load in Manitoba. Combined, this additional electric load would be equivalent to approximately two generating stations the size of Conawapa. **It is important to recognize that the implications to the utility go beyond the analysis provided within this report.** The consequence of a significant fuel switching scenario would also require a substantial investment in additional generation, transmission and distribution infrastructure. In addition, the utility would be confronted with managing a more diverse winter/summer load.

From the natural gas perspective, the remaining annual natural gas load would be 40% of the existing load and as such, the scenario would require a rate increase to the remaining natural gas customers to cover fixed costs (i.e. the fixed costs would need to be recovered from a much smaller customer base). It should be noted that the theoretical potential impact of all customers switching to natural gas space and water heating is also not possible with today's natural gas infrastructure. The implications of this theoretical scenario would also require extensive new infrastructure at an extraordinarily high cost.

The potential impacts of fuel switching in Manitoba for space and water heating can be significant. Given the economic drivers from a customer's perspective, it is unlikely that the Manitoba market will experience any overwhelming shift in space heating from natural gas to electricity, provided customers are informed on their choices. With water heating, the drivers are substantial enough that Manitoba Hydro expects to see a continued market shift from natural gas to electricity.

Manitoba Hydro recognizes the value customers place on having choice and the Corporation does not intend on mandating a specific fuel be used for space and water heating. Where appropriate, the Corporation prefers to use market intervention mechanisms (e.g. education, direct financial incentives, rate design options, etc.) to influence the market.

GAC/MH II-2

Subject: **Fuel Switching Report**
Reference: **Response to Directive 17 Board Orders 116/08 and 150/08**

Please provide all workpapers supporting the report, in Excel spreadsheet form with all formulas intact.

ANSWER:

Please see Manitoba Hydro's response to GAC/MH I-3(a).

GAC/MH II-3

Please include the workpapers for the following tables in Excel spreadsheet form with all formulas intact:

a) **"Net Economic Impact – 2011 Energy Forecasts" on page 28,**

b) **"Net Financial Impact of Fuel Switching (over the life of the equipment) for the Average Residential Home" on page 32,**

c) **The two tables entitled Portion of "2011 Forecast Attributed to Fuel Switching" for both electric and gas sales in Section 4.2.1,**

d) **"Potential Annual GHG Impacts (Attributed by Region due to Fuel Use by MB Residential Customer)" on page 21,**

e) **"Potential Annual GHG Impacts" on page 29,**

f) **"Net Impact of Fuel Switching to Geothermal (over 25 years) - Average Residential Home (on page 30),**

g) **"Net Financial Impact of Fuel Switching (over the life of the equipment) - Average Residential Home" under increased natural gas prices, on page 32,**

h) **"Provincial Inflow (Leakage) Over the Life of the Equipment" on page 33, and**

i) **"Impact of Fuel Switching – Average Residential Home" on page 37.**

ANSWER:

Please see Manitoba Hydro's response to GAC/MH I-3(a).

GAC/MH I-3

Subject: **Rate Design**
Reference: **Bill Comparisons, Appendix 10.3**

a) **Please provide Excel versions (with formulas intact) of the spreadsheets used to derive the bill comparisons in Appendix 10.3.**

ANSWER:

Manitoba Hydro has been reviewing its ability to file electronic spreadsheets and has done so in some instances in this General Rate Application. Manitoba Hydro has not resolved concerns outlined below so as to be able to file electronic spreadsheets in all cases.

First, certain models used by the Corporation are large and complex. Manitoba Hydro expects that an independent analyst, untrained with Manitoba Hydro's models, would need to invest a significant amount of time and effort to be capable of operating the model correctly. Allowing other parties to work in and modify spreadsheets and pose questions in Information Requests and on cross-examination based on the modified schedules, will also require Manitoba Hydro to invest a significant amount of time analyzing the changes made to the spreadsheets and to understanding their potential impacts. This approach is inefficient, would require additional time to be provided within the regulatory process and would make the regulatory process more cumbersome.

Second, certain spreadsheets contain significant metadata, which includes working notes and references made by the staff responsible for the files which cannot be disclosed for confidentially or other reasons. In these situations, in order to remove the metadata, the file must be converted to an Adobe Acrobat portable document format (pdf) file. This is an electronic file format that is an open standard which is readable by many different operating systems, does not require specific software to read and allows all parties to access filed information.

Third, Manitoba Hydro notes that some of the Corporation's models may be subject to intellectual property rights reserved by third parties and are not available to be shared in the regulatory process. In addition, some spreadsheets may contain competitive or commercially sensitive information which is not appropriate to be disclosed.

In these situations, it is preferable for Intervenors to propose, through the interrogatory process, that Manitoba Hydro run specific scenarios using its models, changing the assumptions as requested, and providing updated results for all parties to examine. Manitoba Hydro is of the view that this is the most appropriate and efficient approach to test new scenarios.

GAC/MH II-6

Subject: **Fuel Switching Report**

Reference: **Response to Directive 17 Board Orders 116/08 and 150/08, the two tables on pp. 10-11.**

c) With reference to (b), explain the differences between retrofit and new construction installations.

ANSWER:

The variance between retrofit and new construction is a result of the dynamics of how each market sector operates within a competitive market environment, with each market sector having its own marketing and pricing characteristics. For example, in the new home construction market, most builders offer a standard cost for heating systems whether the customer requests a standard natural gas or electric heating system and regardless of whether the builder can install one system at a lower cost. In the retrofit market, there are less economies of scale and there may be higher costs due to specific home requirements (e.g. upgrade to electric panel).

GAC/MH II-7

Subject: **Fuel Switching Report**
Reference: **Response to Directive 17 Board Orders 116/08 and 150/08, pp. 11-13.**

d) Please explain why the Natural Gas Conventional (Natural Draft) Water Heater is not included as an option in new residential construction (table on page 12).

ANSWER:

The Fuel Switching Report includes an analysis based on the Manitoba market. In the Manitoba new residential construction market, virtually all homes are constructed with electric hot water heaters due to cost considerations.

All new homes using natural gas for space heating are required by code to install a high efficiency natural gas furnace. High efficiency natural gas furnaces are side-venting and do not require a chimney. Conventional natural gas water heaters require a chimney to meet building code requirements to ensure safe venting of flue gases. As observed in the new home construction industry, home builders and home owners install electric hot water tanks and avoid the additional cost of constructing a chimney solely for the purpose of venting the conventional natural gas water heater.

GAC/MH II-7

Subject: **Fuel Switching Report**
Reference: **Response to Directive 17 Board Orders 116/08 and 150/08, pp. 11-13.**

h) **Please provide the simple payback period in the retrofit market for an electric tank-type water heater when compared to a conventional natural gas water heater, with and without chimney sleeve costs.**

ANSWER:

The simple payback period for purchasing an electric water heater compared to purchasing a conventional natural gas water heater can be calculated using the information provided in the Fuel Switching report (i.e. data in the chart on page 12):

- The incremental cost of purchasing an electric water heater compared to a conventional natural gas water heater is $100 (i.e. $1,000 - $900).
- The annual incremental cost for operating an electric water heater compared to a conventional natural gas water heater is $127 (i.e. $236 - $109).
- There is no payback period of purchasing an electric hot water tank compared to purchasing a conventional natural gas water heater as the capital and operating cost associated with an electric hot water tank is higher. The payback period of purchasing a conventional natural gas hot water tank is less than one year.

The simple payback period for purchasing an electric water heater when compared to replacing a conventional natural gas water heater where the customer requires installation of a chimney sleeve to ensure proper venting, is:

- The savings from purchasing an electric water heater compared to a conventional natural gas water heater including the approximate cost of installing a chimney sleeve is $450 (i.e. $1,000 - $1,450).
- The annual incremental cost for operating an electric water heater compared to a conventional natural gas water heater is $127 (i.e. $236 - $109).
- There is no payback period of purchasing an electric hot water tank compared to purchasing a conventional natural gas water heater (with a chimney sleeve requirement) as the operating cost associated with an electric hot water tank is higher. The payback period of purchasing the natural gas hot water tank is approximately 3.5 years.

A water heater has an average useful life of approximately 10 years.

GAC/MH II-12

Subject: **Fuel Switching Report**
Reference: **Response to Directive 17 Board Orders 116/08 and 150/08, p. 27.**

Regarding the computation of the fuel-switching-related energy in the two tables in Section 4.2.1, please provide the following information concerning the fuel-switching residential customers:

a) **The number of existing homes in 2011/12, broken out by space heating source;**

ANSWER:

The following table indicates the total number of existing homes in gas available areas, by space heating source:

Year	Natural Gas	Electric	Geothermal	Other
2011/12	237,246	153,590	7,940	49,313

GAC/MH II-12

Subject: **Fuel Switching Report**
Reference: **Response to Directive 17 Board Orders 116/08 and 150/08, p. 27.**

Regarding the computation of the fuel-switching-related energy in the two tables in Section 4.2.1, please provide the following information concerning the fuel-switching residential customers:

k) **The number of existing residential customers with gas water heating converting to electric tank-type water heating, by year.**

ANSWER:

The following table presents the number of existing residential customers with natural gas water heating forecast to switch to electric water heating each year.

Year	Existing Gas Homes (single detached, multi-family & apartments) Switching to Electric Water Heat
2011/12	2,581
2012/13	3,956
2013/14	4,985
2014/15	4,536
2015/16	4,379
2016/17	4,228
2017/18	3,899
2018/19	3,691
2019/20	3,511
2020/21	3,303
2021/22	3,133
2022/23	3,023
2023/24	5,078
2024/25	5,646
2025/26	3,800
2026/27	2,866
2027/28	2,447
2028/29	2,279
2029/30	2,195
2030/31	2,177

GAC/MH II-12

Subject: **Fuel Switching Report**
Reference: **Response to Directive 17 Board Orders 116/08 and 150/08, p. 27.**

Regarding the computation of the fuel-switching-related energy in the two tables in Section 4.2.1, please provide the following information concerning the fuel-switching residential customers:

o) **If this computation includes new residential customers that have access to natural gas but select electricity for space and water heating, please provide**

i. **The number and percentage of new residential customers with gas access estimated to select hot air/baseboard electric heating.**
ii. **The average reduction in gas use and increase in electric use for space heat of new residential customers selecting hot air/baseboard electric heating over gas.**
iii. **The number and percentage of new residential customers with gas access estimated to select heat-pump heating.**
iv. **The average reduction in gas use and increase in electric use for space heat of the new residential customers selecting heat-pumps over gas.**
v. **The number and percentage of new residential customers with gas access estimated to select electric water heating.**
vi. **The average reduction in gas use and increase in electric use for water heating of the new residential customers selecting electric water heating.**
vii. **The number and percentage of new residential customers with gas access estimated to select gas space heating and electric water heating.**
viii. **The average gas use and electric use for water and space heating of residential customers selecting electric water heating and gas space heating.**

ANSWER:

i. The following table presents the number of new residential customers in gas available areas that are forecast to select electric space heating each year:

Year	Number of New Homes in Gas Available Areas Installing Electric Space Heat (single detached, multi-family & apartments)	Percentage of New Homes in Gas Available Areas Installing Electric Space Heat (single detached, multi-family & apartments)
2011/12	1,911	48%
2012/13	2,149	47%
2013/14	2,378	47%
2014/15	2,392	47%
2015/16	2,440	47%
2016/17	2,475	47%
2017/18	2,476	47%
2018/19	2,447	47%
2019/20	2,413	46%
2020/21	2,376	46%
2021/22	2,332	46%
2022/23	2,285	45%
2023/24	2,233	45%
2024/25	2,177	45%
2025/26	2,118	44%
2026/27	2,058	44%
2027/28	1,996	44%
2028/29	1,934	43%
2029/30	1,871	43%
2030/31	1,809	43%

ii. The average reduction in gas use for space heat of new residential customers selecting hot air/baseboard electric heating over gas is 958 m^3 per year. The average increase in electric use is 9,119 kWh per year. This includes single detached homes, multi-family residences and apartments. The average use per year includes a combination of electric furnace and geothermal installations.

iii. For the 2011 Electric Load Forecast, approximately 250 new residential customers with natural gas access were forecast to install geothermal heating each year. This represents approximately 5% of new dwellings constructed in gas available areas.

GAC/MH II-15

Subject: **Fuel Switching Report**
Reference: **Response to Directive 17 Board Orders 116/08 and 150/08, p. 27.**

Please provide any available data on

c) **The number and percentage of new customers with access to natural gas choosing to use electricity for space and/or water heating, by class, for each year 2000–2011.**

ANSWER:

The 2009 Manitoba Hydro Residential Energy Use Survey estimated that, between 2005 and 2009, there were 9,781 new residential customers in gas available areas who installed electricity for space heating, or 1,956 per year. This represents 54% of the 3,654 new customers in natural gas available areas per year as outlined in Manitoba Hydro's response to GAC/MH II-15(a).

In addition, between 2005 and 2009, 15,098 new residential customers in gas available areas were estimated to have installed electricity for water heating, or 3,020 per year. This represents 83% of new customers in natural gas available areas. However, only 2% chose natural gas water heating; the remaining 15% of new residential customers indicated that water heating was provided as a common service (i.e. not reflected on the customer's bill).

For the commercial sector, detailed data was not available. The annual growth of natural gas customers was approximately 80 customers per year; 40 customers per year were assumed to install electricity instead of natural gas for space and water heating. New commercial customers in natural gas available areas were assumed to install electric space and water heating at the same rate as experienced among existing customers in the residential sector, or 33%.

GAC/MH II-15

Subject: **Fuel Switching Report**
Reference: **Response to Directive 17 Board Orders 116/08 and 150/08, p. 27.**

Please provide any available data on

d) **The GWh of annual electric load added by class, for each year 2000–2011, due to new customers with access to natural gas choosing to use electricity for space and/or water heating.**

ANSWER:

Detailed data on the number of new customers with access to natural gas choosing to use electricity for space and water heating and associated GWh of electric load is not available for the period of 2000 to 2011.

The annual GWh impact of 1,956 new residential dwellings in gas available areas installing electric space heat, assuming an average annual use of 9,119 kWh per residence (single detached, multi-attached and apartments) is estimated to be 17.8 GWh.

The annual GWh impact of 3,020 new residential dwellings installing electric water heating, assuming an average annual use of 3,489 kWh per water heater, is estimated to be 10.5 GWh.

The annual GWh impact of 40 new commercial dwellings installing electric space and water heat, assuming an annual average energy use of 138,298 kWh per space heating system and 26,976 kWh per water heating system, is estimated to be 5.5 GWh and 1.1 GWh respectively.

GAC/MH II-15

Subject: **Fuel Switching Report**
Reference: **Response to Directive 17 Board Orders 116/08 and 150/08, p. 27.**

Please provide any available data on

e) **The number of existing customers switching from electricity to gas for space and/or water heating and the resulting electric GWh annual load reduction, by class, for each year 2000–2011.**

ANSWER:

The number of customers converting from electricity to natural gas heating is estimated to be negligible.